

Length-weight relationships (LWRs) revealing the impacts of multiple conditions factors for sustainable fisheries of four small indigenous fish species inhabiting in wetlands of Bhopal, M.P., India

Jyoti Sharma¹, Anubhuti Minare¹, Vipin Vyas¹ and R.K. Garg²

¹Department of Zoology and Applied Aquaculture, Barkatullah University, Bhopal 462 026, M.P., India

²Department of Bioscience, Barkatullah University, Bhopal 462 026, M.P., India

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ABSTRACT

The length-weight relationships (LWRs) and relative condition factors are prodigious significance in aquaculture assessment because it provides information about the growth of fishes, its general wellbeing and fitness in the freshwater habitat. Therefore, present investigation was carried for length-weight relationship (LWR) of four small indigenous fish species (*Securiculagora*, *Amblypharyn godonmola*, *Rasbora daniconius*, and *Gudusia chapra*) from the wetlands of Bhopal, Madhya Pradesh. A total of 209 specimens were caught by traditional gear method during August 2023 to January 2024. Length (cm) and body weight (g) for each specimen were taken after immediate collection of the specimens. During the research work the values of the exponent 'b' in LWR ($W=aL^b$) were found as 2.774 (*S. gora*), 2.888 (*A. mola*), 2.959 (*R. daniconius*), and 1.988 (*G. chapra*) which showed a negative allometric growth pattern. The result further indicated that *S. gora* and *R. daniconius* had a high correlation, good in *A. mola*, and moderate in *G. chapra*. This study provided the first baseline information about LWRs of small indigenous fish species from the water bodies of Bhopal. These details are valuable for the establishment a monitoring and management systems of these fish species.

Key word : Length-weight relationship (LWR), Values of the exponent, Condition factor, Small indigenous fish species, Bhopal.

Introduction

Fishes are an essential dietary component because of its high protein content. Unfortunately, fish stocks are plummeting worldwide notable in freshwater ecosystems mainly because of two factors overexploitation of certain fish species and the environmental degradation caused, among other things, like by pollution (Zhou *et al.*, 2010). Fish stocks are usually monitored through fisheries are still collapsing in some areas of the world despite efforts to sus-

tain a healthy environment and preserve both fish diversity and biomass (Tsikliras *et al.*, 2015).

The Small Indigenous fish species are those which attain a length of about of 25 cm or 6 inches at maturity (Felts *et al.*, 1996) and rich source of nutrients. *Securicula gora*, *Amblypharyngodon mola*, *Rasbora daniconius*, and *Gudusia chapra* are small indigenous fish species belonging to the Cyprinidae family, which is the largest family of freshwater fish. They are all relatively small to medium-sized fishes except *Gudusia chapra*, reaching a maximum length of

1 metre (Rahman, 1989). Kongsback *et al.*, (2008) studied the consumption of nutrient-rich freshwater small indigenous fish by human beings and stated that SIFs provide better nutrition since they are generally eaten as a whole, including the head, bones, and eyes, and thus all available nutrients, including the micronutrients, get utilized. These fish are equally well known for being rich sources of proteins, fatty acids, vitamins, and minerals.

The length-weight relationship is a very important aspect of the biology of any fish, particularly when the fish is to be reared commercially. Due to variations in season, food composition, and multiple spawning, growth fluctuations are more common in fish in tropical and subtropical waters (Lagler, 1956). The relationships between length and weight have been applied for the assessment of fish stocks and population (Ricker, 1968). Ricker (1975) also stated that length-weight relationships and fish growth is allometric or isometric in fisheries studies. There are three different growth types were reported: positive allometric ($b > 3$), isometric ($b = 3$) and negative allometric ($b < 3$). Length-weight relationships have potential effects on fisheries resource management and population dynamics (Erzini, 1994); they may change during events of the life cycle like metamorphosis, growth, and the onset of maturity (Le Cren, 1951). The precise relationship between length and weight differs among species of fish according to their innate body shape and within species according to the condition of individual fish (James *et al.*, 2000).

Currently, there are limited studies done on the small indigenous fish in the wetlands of Bhopal, Madhya Pradesh, India, which emphasise the length-weight relationship and their relation to environmental conditions. Therefore, this study aims to describe the length-weight relationship of *Securicula gora*, *Amblypharyngodon mola*, *Rasbora daniconius*, and *Gudusia chapra* in the Wetlands of Bhopal, Madhya Pradesh, India.

Material and Methods

Study area samples collection

The fishes were collected from different markets of Bhopal city includes Kasturba Market, Govindpura Market and Barkheda Market and Piplani Market. Fishes in these fish market were brought from different reservoirs around the Bhopal City. Fish were also

caught randomly using a mid-water trawl using fishing cages. The fish specimens were collected from the market and brought to the laboratory of Department of Zoology and Applied Aquaculture, Barkatullah University, Bhopal for further analysis of Length-Weight Relationship (LWR) of some Small Indigenous Fish Species.

Length-Weight Relationship

The relationship between length and weight of fish was analysed by measuring length and weight of fish specimens collected from different markets. Total length (TL) in cm and total weight (TW) in gm for each individual were measured using digital slide calipers and an electronic balance, respectively (Simon and Mazlan, 2008; Alam *et al.*, 2012). The statistical relationships between these parameters of fishes were established by using the parabolic equation: $W = aL^b$,

W= Weight of the fish in grams (g)

L=Total length of the fish (cm)

A=Constant (intercept)

B=the length exponent (slope), (Froese, 2006).

The relationship ($W = aL^b$) when converted into the logarithmic form gives a straight liner relationship graphically.

$\log W = \log a + b \log L$

Where, b represents the slope of the line, log a is constant.

The log transformation formula of Le Cren was used to establish LWRs (Le Cren, 1951). The length-weight equation $W = aL^b$ was used to estimate the relationship between the weight (g) of the fish and its total length (cm). Using the linear regression of the log transformed equation: $\log(W) = \log(a) + b \log(L)$, the parameters a and b were calculated with 'a' representing the intercept and 'b' the slope of the relationship.

Results

The present investigation was carried on length-weight relationships (LWRs) and condition factors for the small indigenous fishes, i.e. *Securicula gora*, *Amblypharyngodon mola*, *Rasbora daniconius*, and *Gudusia chapra* collected from the different markets of Bhopal, Madhya Pradesh, India who representing important wetlands of Bhopal. A total of 209 fish specimens were caught from local market and from different wetlands by traditional gear method during August 2023 to January 2024. Length (cm) and

body weight (g) for each specimen were taken after immediate collection of the specimens.

Average length and weight

Total of 209 fish specimens were caught from local market and from different wetlands were measured at site and laboratory by standard method. Details of the morphometric measurements month wise average of four important fishes has been given in Table-1. The total length ranged from 8.2 to 15.3 cm and the total weight of the fish varied from 4.07 to 21.97 gm for *Securicula gora*. The total length ranged from 8.1 to 10.1 cm, and the total weight of the fish varied from 5.42 to 11.4 gm for *Amblypharyngodon mola*. The total length ranged from 6.6 to 11.5 cm, and the total weight of the fish varied from 2.73 to 13.1 gm for *Rasbora daniconius*. The total length ranged from 10.2 to 17.6 cm, and the total weight of the fish varied from 9.81 to 30.7 g for *Gudusia chapra*. Every effort was made to have a random sampling, therefore, included all size groups for all four small indigenous fish species.

Length-Weight Relationship

The study of length-weight data of these fish species

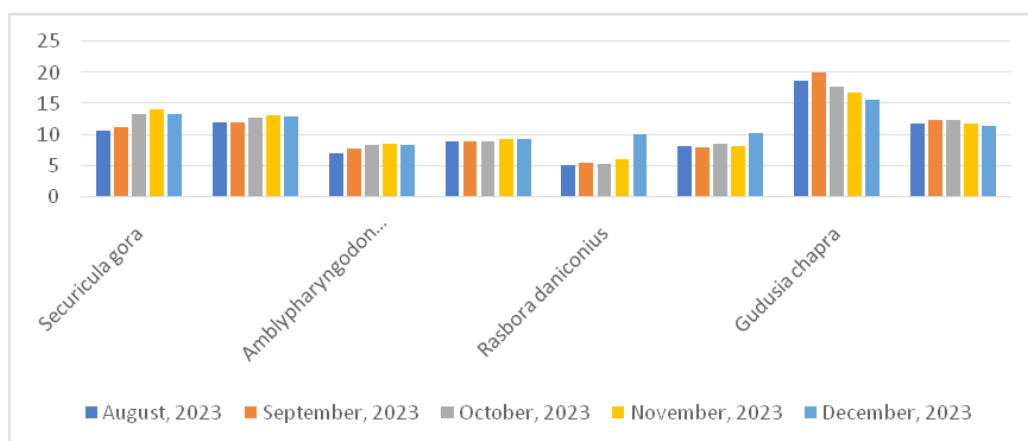
will be helpful in fishery management so as to maximize the growth in minimum possible time. All the observed actual values have been plotted on the graphs with total length on X-axis and total weight on Y-axis. To simplify data interpretation, total length and total weight values have been converted to logarithmic scale. Hence a linear relationship i.e., a straight-line curve has been obtained for all the fish species. All the calculations of length-weight data are based on log values and not on the original values. The regression equation based on logarithmic values are given for the extrapolation of results. For extrapolation, the log total length value has been used which gives log weight and by calculating anti log of the log weight, it gives the calculated weight of fish.

Regression Equation

The value of correlation (r) between total length and total weight is obtained through statistical analysis (by using SPSS version 29.0 software) for all the species. The value of correlation coefficient was 0.968 (*Securicula gora*), 0.862 (*Amblypharyngodon mola*), 0.961 (*Rasbora daniconius*), and 0.778 (*Gudusia chapra*), which shows high correlation (*Securicula*

Table 1. Month wise average length and weight of four important fishes.

Month	<i>Securicula gora</i>		<i>Amblypharyngodon mola</i>		<i>Rasbora daniconius</i>		<i>Gudusia chapra</i>	
	TW	TL	TW	TL	TW	TL	TW	TL
August, 2023	10.74083	12.06667	7.087273	8.881818	5.23	8.190909	18.7125	11.925
September, 2023	11.32333	11.95833	7.851818	8.918182	5.465455	8.109091	20.0625	12.4625
October, 2023	13.37167	12.76667	8.308182	9.054545	5.390909	8.509091	17.69	12.4625
November, 2023	14.03	13.225	8.535455	9.281818	6.023636	8.263636	16.7	11.9125
December, 2023	13.39083	13.00833	8.32	9.290909	10.192	10.27	15.6337	11.4375



Graph 1. The average length and weight of four freshwater fishes studied during August to December, 2023

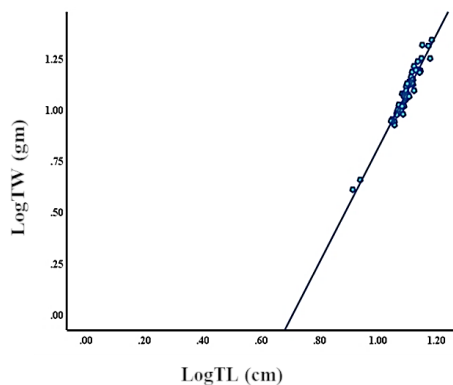
gora and *Rasbora daniconius*), good correlation (*Amblypharyngodon mola*), and moderate correlation (*Gudusia chapra*). The values of the exponent 'b' in LWR ($W=aL^b$) were 2.774 (*S. gora*), 2.888 (*A. mola*), 2.959 (*R. daniconius*), and 1.988 (*G. chapra*), showing a negative allometric growth pattern. The LWRs are obtained as $W=0.01083927L^{2.774}$, $0.013551894L^{2.888}$, $0.010162487L^{2.959}$, and $0.12302688L^{1.988}$ for *S. gora*, *A. mola*, *R. daniconius*, and *G. chapra* respectively. These values in graphical representation for all small indigenous species has been given in Graph 1 to Graph 5.

Discussion

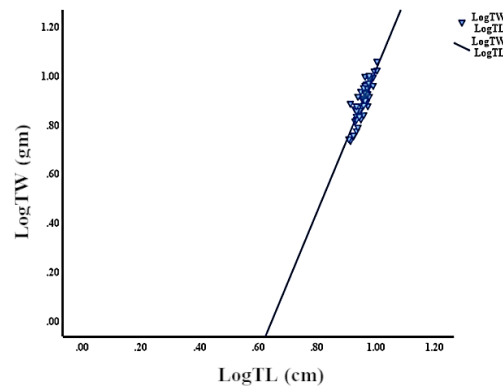
The relationship between length and weight differs among fish species according to the body shape, and within the same species according to the condition (robustness) of individual fish. LWRs are not constant over the year and LWR parameters may vary significantly due to food availability, biological, temporal, and sampling factors. Alam *et al.* (2013) stud-

ied Length-length relationship, length-weight relationship, and condition factor of freshwater fish species in Bangladesh, which include *Esomus danricus*, *Amblypharyngodon mola*, *Pethia ticto*, and *Glossogobius giuris*. Relationship equations among different body length parameters of each species were found to be highly significant ($p<0.01$). LWRs were obtained as $TW=0.008TL^{3.01}$, $0.025TL^{3.03}$, $0.043TL^{2.93}$ and $0.021TL^{2.91}$ for *E. danricus*, *A. mola*, *P. ticto*, and *G. giuris* respectively. The present study of LWRs shows $TW=0.013551894TL^{2.888}$ for *A.mola*, and the value of 'b' is found to be 2.888 which shows a negative allometric pattern of growth. The coefficient of correlation (r) is recorded to be 0.862, which shows a good correlation between the fish species.

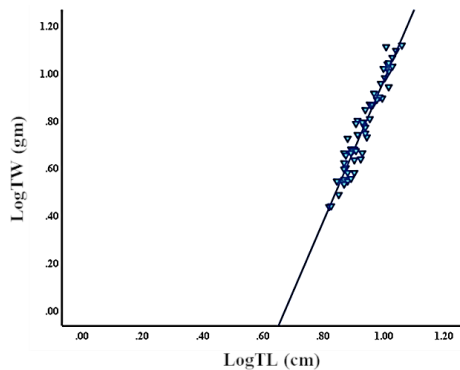
In addition, the correlation coefficient values are 0.968 (*S. gora*), 0.961 (*R. daniconius*), which shows high correlation, and 0.778 (*G. chapra*), which shows moderate correlation. The values of the exponent 'b' in LWR ($W=aL^b$) were 2.774 (*S. gora*), 2.888 (*A. mola*), 2.959 (*R. daniconius*), and 1.988 (*G. chapra*), showing a negative allometric growth pattern. The LWRs



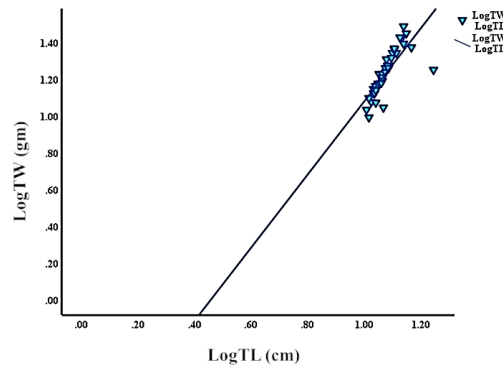
Graph 2. Correlation between LogTL (cm) and Log TW (gm) of *Securicula gora*.



Graph 3. Correlation between LogTL (cm) and LogTW (gm) of *Amblypharyngodon mola*.



Graph 4. Correlation between LogTL (cm) and LogTW (gm) of *Rasbora daniconius*.



Graph 5. Correlation between LogTL (cm) and LogTW (gm) of *Gudusia chapra*.

were obtained as $W=0.01083927L^{2.774}$, $0.013551894L^{2.888}$, $0.010162487L^{2.959}$, and $0.12302688L^{1.988}$ for *S. gora*, *A. mola*, *R. daniconius* and *G. chapra* respectively.

In comparison with the earlier estimates, some variations in *b* values in the present study were observed, which may be attributed to various factors, such as fish physiology, growth phase, sex, sexual maturity, season, stomach fullness, length range and sampling size, habitat, feeding rate, diet, and health (Le Cren, 1951; Froese *et al.*, 2011; Mondol *et al.*, 2017). Most of the LWR obtained from this study agreed with those reported from the previous ones. The estimated growth type in this study coincides with those previously recorded (Kara *et al.*, 2017; Huang *et al.*, 2018).

Conclusion

The biological information like LWRs, generated from this investigation will be useful for further population studies and stock assessment which in turn find its application in sustainable management measures of these commercially important small indigenous fish species. Therefore, investigation carried out in this work provided some new and updated information on LWRs of 4 small indigenous species *Securicula gora*, *Amblypharyngodon mola*, *Rasbora daniconius*, and *Gudusia chapra*. Information derived from the present investigation may play an important role in management and conservation of these four freshwater small indigenous fish species. It will be useful for fishery biologists/managers to impose adequate regulations for sustainable fishery management in Bhopal, Madhya Pradesh, India. Even though these parameters were estimated for sexes combined, they still have great importance for fisheries managers as there are no specific gears for each sex and any fisheries regulations are taken for the whole stock or population.

Conflict of Interest- None

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